



Mantle metasomatism by primary carbonatite melts found in melt inclusions in clinopyroxenite xenoliths from lamprophyre dikes, Hungary

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Several metasomatic xenoliths were found in two lamprophyre dikes, Hungary. The xenoliths are composed of clinopyroxene (Cpx), apatite (Ap), K feldspar (Kfs), and phlogopite (Phl). Ap and Kfs are always coexisting phases and they are the only phases that contain primary carbonatite melt inclusions (CMI). Post-entrapment crystallization processes within the CMI onto the walls produced “wall-apatite” and “wall-K feldspar”, respectively. EMPA and LA-ICP-MS techniques have been carried out on numerous intact CMI. In general, Ap and Kfs enclosed a P-bearing dolomitic and a Si-rich dolomitic carbonatite melt, respectively. However, Ap contains two types of CMI. Type-1: SiO₂-poor (1.5-10 wt%) CMI composes the great majority, 90%. Type-2: Silicate-bearing CMI (SiO₂ >15 wt%), 10%. Rarely, Kfs-hosted CMI contains a P₂O₅- and carbonate-rich globule. Based on the solubility of apatite in carbonatite melts (Baker and Wyllie, 1992), the equilibrium T of CMI was calculated to be between 1190°C and 1070°C. There are two indications for liquid-liquid separation between a P-bearing and a Si-rich carbonatite melt (1) Type-2 CMI in apatite probably represent heterogeneously entrapped carbonatite melts containing drop(s) of both phosphorous-bearing and Si-rich carbonatite melt. Accordingly, K feldspar rarely contains CMI that include a P- and carbonate-rich globule. (2) Si/Al molar ratios in Ap-hosted CMI are in a wide range, 2.3-52 (15 in average) showing that their compositional diversity is resulted in a heterogeneous entrapment of a non-stoichiometric

material.

PM normalized trace element distributions of the Ap- and Kfs-hosted CMI reveal a strong negative Ti anomaly, and an extreme enrichment in the incompatible LILE and LREE relative to HREE and the compatible elements. The relative La/Lu to PM is in the range of 107-147, furthermore, PM-normalized U, Th, Sr show ~one million times higher value than those of Ni and Cr. This indicates that the initial melt of the CMI was formed with a very low degree partial melting of a carbonated source. Chemical characteristics of the CMI are clearly reflected in the clinopyroxene compositions, showing that formation of the clinopyroxenes was linked to the metasomatic carbonatite melt trapped as CMI in the studied apatite and K feldspar. The studied xenoliths also reveal that modal metasomatism happened, however; clinopyroxenes which occur in the studied xenoliths with high modal proportion of Ap, contain Ti, Sc, Ni, V and especially Cr in much lower concentration than those clinopyroxenes which occur with low modal proportion of Ap. Coincidentally, distributions of Zr and Hf in Cpx show an opposite pattern. All of the studied CMI reveal that the “initial” carbonatite melt possessed much lower Ti, Sc, V, Cr, Ni, and contrarily, much higher Zr and Hf contents than the PM. Consequently, a continuously migrating “initial” carbonatite melt, which crystallized the host Ap and Kfs, increased Zr and Hf concentrations, whereas, decreased the amount of Ti, Sc, V, Ni and Cr in the clinopyroxenes. All of these supports that the studied CAKP rocks were formed by carbonatite melt metasomatism, which occurred in an open system in peridotitic environment.